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ABSTRACT

Faculty experience at the College of Staten Island--City University of New York shows that Hybrid Analog Digital Networks (ADViNet) prove to be useful in the classroom environment. They support major instructional activities, and are very efficient in the distribution of full-screen motion video and other graphical images. The ADViNet does not introduce extra traffic in the local area network, and does not slow down other network operations. The use of a video network is an efficient and effective teaching tool in those courses where the course content is completely new to the students, requiring extensive use of lecture and presentations from visual sources. In advanced classes, laboratories, and seminars, video networks have prove productive for modeling, individual and group tutoring, and monitoring. Student surveys suggest that the students like to take classes in a classroom equipped with a video network. They prefer video networks to other systems of video distribution (such as big screens) and consider it an effective teaching tool. (SWC)

Video Networks in an Electronic Classroom Environment and Analysis of Student Preferences in the Development of a Network-Based Video Distribution System

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Introduction

The Electronic Learning Environments currently available can considerably improve teaching effectiveness. Networked multimedia computers enhance instruction by facilitating the distribution of text, graphics, sound and video images, providing communication links, and allowing continuous monitoring of student work.

The distribution of video images is important in computer science courses. The ability to present visualizations of programming concepts and actual procedures on each computer screen is an effective pedagogical tool. Computer procedures and program outputs are for the most part visual phenomena. Students learn much more rapidly when they do not have to continually translate a verbal description into a picture of what appears on the computer screen.

Networked computer laboratories are usually configured as a digital network of an instructor's workstation and students' personal computers. A large monitor attached to the teacher's workstation or an LCD panel on a overhead projector serves for demonstration purposes. In these laboratories, the instructor usually presents material at the front of the room and then rotates among the students answering individual questions. This setup is not particularly conducive to maintaining students' attention nor does it lend itself easily to collaborative activities.

Superimposing an analog video network such as COMWEB[1], Tech Commander[2] or V-Net[3] over the digital network improves upon the above configuration in several ways. Real- time, full motion video information is distributed to each individual computer screen. The source of the video information can be the teacher's computer, a student's computer or an auxiliary device. In addition, the teacher can monitor classwork by successively scanning each student's screen. See Figure 1.

The faculty at the College of Staten Island currently use the COMWEB system. In a continuing evaluation of this electronic learning environment, the faculty have noted the following advantages. One of the most difficult aspects of teaching in a networked computer laboratory is holding students' attention while delivering instructions. When the professor has control of all the mice and keyboards the students cannot wander to other activities while the professor is introducing the exercise. The distribution of the image to individual screens improves each student's visibility over the more traditional large monitor or overhead projector.

PHYSICAL STRUCTURE OF THE HYBRID ANALOG/DIGITAL VIDEO NETWORK

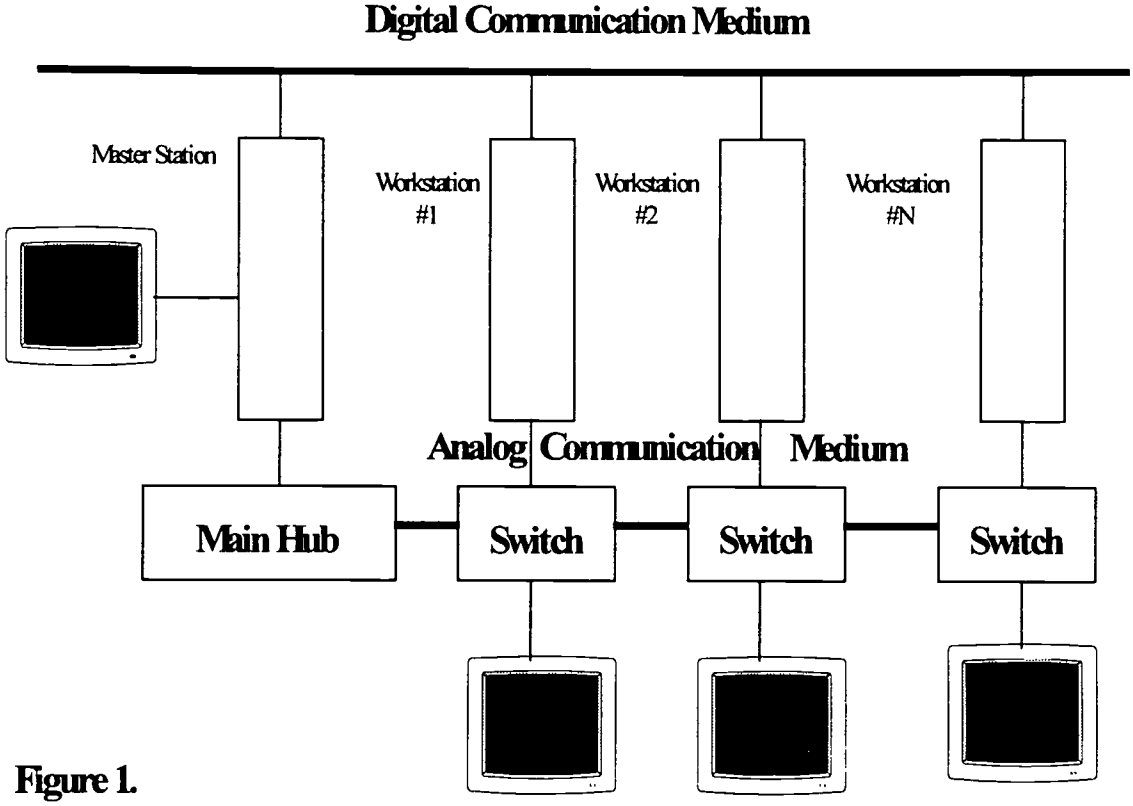

Figure 1.

The faculty also reach beyond the presentation capabilities of the system and use it to enhance students' performance while they are working independently on laboratory exercises. The COMWEB system displays each student's screen on the teachers' station for a specified period of time so that the professor can easily check who is working on the assigned task. This continual monitoring of class performance facilitates just-in-time feedback to the class. Students who are procrastinating can be brought back on track before significant time is lost. Professors can coach

students who are following fruitless paths of investigation or are stuck at a dead end before they fall too far behind.

The professor can also spend more time watching the work of a small sample of students without drawing their attention away from their work. This quiet review facilitates the professor's understanding of the thought processes or the direction which an individual or group of students is taking. By sharing the screens of a selected group of students, a professor can encourage collaborative activities to solve more challenging problems.

Evaluation of Student Performance and Student Response to the COMWEB System

Faculty members who teach with the COMWEB system have conducted evaluations of the system in order to explore its advantages and to suggest possible areas for further improvement. One of the first evaluations of the COMWEB examined student performance in a computer literacy course, "Computing for Today". This course consists of three parts which include word processing, "Word Perfect", database, "dBASE IV", and spreadsheet, "Quattro Pro". Each part can be considered as a separate five-week course which incorporates a set of special assignments and an examination. Two sections were studied, one using the COMWEB system in addition to the college's digital network and one using only the digital network.

Although the sample size is small and only describes two sections, the numbers in the chart show substantial improvement in student performance in both the database and spreadsheet subsections of the course. These numbers suggest that the students in the sections using COMWEB grasped both the procedures and the concepts much better than the control group. The decrease in the average deviation is intriguing. Faculty using the COMWEB system perceive that more students in the class are engaged in the lesson and receiving feedback from the professor than in an ordinary networked computer laboratory. If this decrease in the average deviation is found consistently in further studies, it would support the faculty's proposition. See Table 1.

In a second evaluation of the COMWEB system, two classes were surveyed, a computer science major course and a computer literacy course. In both classes, two professors used COMWEB system extensively. The Computer Science course, CSC 430 covers software engineering using Visual Basic; CSC 122 teaches computer literacy in Windows 3.1.

The students in both classes appreciated the video distribution of images to their own screens. The majority of students in both classes indicated they preferred a video distribution of the teacher's screen to individual computer displays rather than to a large screen display. The students also indicated that the COMWEB was an effective teaching tool, agreeing that they understood the material better when the professor was using COMWEB. See Table 2.

While again the sample size is too small to claim to be representative of all the students taking computer science courses, the overwhelming positive response from the students has indicated to the faculty that continued development of a system similar to COMWEB is a worthwhile endeavor.

Comparison of the academic achievements.

Table 1

Subcourse	Section taught without Video Network		Section taught with Video Network	
	Average Grade	Average Deviation	Average Grade	Average Deviation
Word Processor	84.5	9.7	86.9	9.2
Database	71.3	13.9	92.3	6.8
Spreadsheet	73	13.5	93.8	7.1

Student Assessment of Impact on Learning

Table 2

Questions (Sample size N = 31)	Strong/ Moderate Agree	Strong/ Moderate Disagree	No opinion
The screen images distributed over the COMWEB system are clear and focused. I can see the presentation on the screen on my table more clearly that on a screen in front of the room.	26 84%	2 6%	3 10%
I prefer taking a class in which the professor is using the COMWEB system to one in which the professor uses a computer connected to a large screen.	24 77%	2 6%	5 16%
I pay more attention and understand the lecture/demonstration better when the professor is using the COMWEB system.	23 74%	6 19%	2 6%
I understand material better when I am able to see work done by other students in the class.	17 55%	6 19%	8 26%

Technical Considerations

Users of educational technology must be aware of the technical as well as pedagogical advantages or disadvantages of a system. The distribution of video information in a classroom poses difficulties[4]. Any video, especially motion video, requires the transmission of a huge amount of data. This volume of data necessitates paying for large disk space and high data transmission speed. Although current methods of data compression partially solve this problem, it still is troubling.

Transmission of video information interferes with the local area network outside of the classroom. Transmitting video information through the digital medium inside the classroom creates additional traffic outside the classroom in the part of the LAN limited by bridges. This slows down all network activities on the LAN considerably, affecting other classroom, research laboratories, and faculty and administrative offices. One faculty experiment showed that using a telecommunications product CU-SeeMe on 2 to 3 stations increased traffic in the network by up to 40%.

Motion video information is by nature, delay-sensitive because each frame must be delivered on time. The slow down in the local area network completely disrupts the distribution of motion video.

The current system resolves these problems by creating a hybrid analog/digital network. The analog component is dedicated to the video distribution. The digital medium consists of the underlying digital network connecting the computers. The analog medium combines a VGA bus controlled from a master station with several additional control lines. The monitors which are connected to the bus can work in one of two states: 1) local - when the monitor is displaying the work the user is undertaking independently at his/her workstation; 2) remote - when the monitor is connected to a remote source of video information. The COMWEB system, the analog component used at the College of Staten Island, is a pure hardware system which provides physical connections among 36 workstations and a master workstation. A panel with buttons at the master station is used to control the video network manually. Figure 1 shows the physical structure of this network. Several modes of transmission are available on this network. See Table 3.

This architecture has significant technical drawbacks. The centralized control of the analog part of the network prohibits the interactivity of the network because only one station at a time can be active. When the monitor is in the remote mode, the workstation is, for all practical purposes, disabled despite the fact that the computer itself can concurrently execute some other task by communicating with other nodes through a digital medium. The COMWEB system lacks a flexible and friendly interface. These deficiencies hinder the wider use of video webs.

Generalized Modes of the COMWEB System.

Table 3

Logical Operation	Physical Mode	Description
Broadcast	Mode 1	Transmit from instructor's station to all student stations.
	Mode 3	Transmit from student's station to all other students.
Multicast	Mode 2	Transmit from instructor's station to one or more student stations.
	Mode 4	Transmit from student's station to one or more other students.
Monitoring	Mode 5	Transmit from all student stations back to instructor (scanning).
	Mode 6	Transmit from one or more student stations back to instructor.

Future Development

Professor Gordonov is developing a two-layer management protocol which substantially improves the existing combination of analog and digital network[5]. The combination of the analog network, the digital network and the management protocol constitutes a hybrid analog/digital video network (ADViNet). This ADViNet seeks to extend the pedagogical advantages and overcome many of the technical difficulties of the COMWEB system now in use.

The pedagogical considerations concern the use of the network for coaching and monitoring individual students and for encouraging collaborative activities among groups of students. The survey administered to the majors course and the computer literacy course suggested that the two groups wanted different teaching styles. The non-majors were much more interested and positive to the idea of individual coaching, while half of the majors expressed no opinion to that question. In contrast, the non-majors were evenly split about developing the network to accommodate small groups of students who want to work together, while the students majoring in computer science were overwhelmingly positive to that idea. See Table 4.

Although this small sample may not be representative of all majors and non-majors, the results suggest that design issues in the future development of the network should take into account the needs of the different populations of students which it will serve.

Different Preferences of Majors and Nonmajors

Table 4

Questions	Strong/Moderate Agree		Strong/Moderate Disagree		No opinion	
	Non-major	Major	Non-major	Major	Non-major	Major
I receive more individual coaching or feedback when the professor is using the COMWEB system	9	6	3	2	3	7
In the future, I would like to be able to work cooperatively with a small group of students, sharing screen images without going through the professor's station.	7	13	6	1	3	1

The multi-level protocol is designed to decentralize the control in the video network. On the physical level, the network will retain all the display features currently available in the video web. The main function of this level is to support manual and programming control of the analog video network. The proposed protocol superimposes a logical level on top of the physical level. This level decentralizes the control of the video network so that any station with appropriate authorization can initiate video distribution or monitoring.

The logical level provides the opportunity for a real-time adaptive response to student performance in the laboratory. Data from each workstation can be fed into a common database. This information can be continually analyzed to decide which stations should be monitored. For example, the professor could choose to watch only those students who are not completing exercises according to a predefined schedule.

The resulting ADViNet system covers all major instructional activities. These include lecture, individual and group tutoring, demonstration/modeling, seminars, test and drills. See Table 5.

Main Instructional Activities in the ADViNet Environment.

Table 5

Instructional Activities	ADViNet Operations	ADViNet Layer Employed
Lecture	Broadcasting	Physical
Individual Tutoring	Multicasting	Physical
Group Tutoring		
Modeling (Teaching by Example)		
Seminars	Broadcasting/ Multicasting	Logical
Tests/Drills	Monitoring	Logical with adaptive network reconfiguration

Summary

Faculty experience shows that Hybrid Analog Digital Networks prove to be useful in the classroom environment. Not only do they support major instructional activities, but they are also very efficient in the distribution of full-screen motion video and other graphical images. The ADViNet does not introduce extra traffic in the local area network and does not slow down other network operations. The multi layer ADViNet protocol will be used for the future development of software aimed at specific network-based instructional functions (real-time coaching, computer assisted intelligent monitoring, group work, and others).

The use of a video network is an efficient and effective teaching tool in those courses where the course content is completely new to the students, requiring extensive use of lecture and presentations from visual sources. In advanced classes, laboratories and seminars, video networks have proven productive for modeling, individual and group tutoring, and monitoring.

Student surveys suggest that the students like to take classes in a classroom equipped with a video network. They prefer video networks to other systems of video distribution (such as big screens) and consider it an effective teaching tool.

Although the faculty is committed to future development of the Hybrid Analog\Digital Network, some intrinsic features of video networks limit their flexibility as compared to digital networks. Understanding this fact defines the direction of the future of the ADViNet development which is to incorporate ADViNet into the global contemporary digital video environments (such as "LearnLink"[6]). This incorporation allows faculty to exploit the benefits of the hybrid video network component in places and situations where it is has a clear comparative advantage over regular digital networks, while not sacrificing the availability of additional features from the sophisticated digital networks.

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